W2 Version 3.12 Release Notes

October 1, 2004

The code, updates and further information on the W2 model are available from the following Web page (subject to change):

http://www.ce.pdx.edu/w2

Please address questions about the code to either

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W2 V3.2 Release

The current release of the model includes the following:

1. The w2 model and preprocessor executables and source code [W2V3 uses dynamic array allocation so the user does not need a FORTRAN compiler and one executable works for all problems.] and an example application

The model source codes and executables are in the file "w2v3.zip". The executables (prew2ve.exe and w2v3.exe) need to be run in the same directory as the input files (*.npt). There is no need to set up additional software to run the code, except perhaps the Array Viewer software from COMPAQ (see next section below). If you do not set up the COMPAQ Array Viewer, you will get an error when running the w2 executable, w2v3.exe. The executables should work with the enclosed example problem. Also a generic FORTRAN source code is included that does not have the COMPAQ Array Viewer information.

2. The GUI preprocessor [A postprocessor is under development but is not ready for release]

The GUI preprocessor is found in the file "gui.zip". There is a "setup.exe" routine that installs the Visual Basic W2 V3.1 Model Preprocessor called W2CONTROL. Once installed, the GUI preprocessor is able to aid the model user in setting up the Control File and in evaluating and changing the bathymetry of the system. This preprocessor does not automatically set-up the bathymetry of the system, nor does it provide post-processing support. A lot of effort is required to properly set-up the model bathymetry prior to using the Bathymetry editor within W2Control. Also, note that on the W2 web page there may be updates to the file "w2control.exe". If there are, copy

this new file over the one installed during the setup program. There is no need to run the setup program again. Note that there is now a separate pdf user manual for the GUI interface.

3. User's Manual

On the web page the User's Manual is provided in a zipped PDF file.

4. A Version 2 to Version 3.1 Converter

This utility, in the file "v2tov31.zip", converts CE-QUAL-W2 V2 files (based on the latest "Workshop" release Version 2) to V3.1 file formats. There is currently not a V3.0 to V3.1 converter.

5. Waterbalance Utility

The code and executable for this are in the file "waterbalance.zip". This utility is released without support at the present time. The purpose of this code is to approximate the waterbalance for a reservoir by computing flows (positive and negative) that will allow the model predicted water level to agree to water level data for a reservoir. There is a short write up Word document in the zip file.

Registration information will be required for model download in order to alert users to bug fixes and enhancements.

W2 Model Assistance for Array Viewer, V2 to V3 Converter, and GUI Interface

The following list provides information to assist the model user to set up the program and files.

#	Item	Description
1	Array Viewer Setup	In order to set up the Array Viewer, you must install the Compaq Array Viewer Demo Version 1.6 or higher. This is available free from the following web site: http://www.digital.com/fortran/aview/getviewer.html [This web address may change.] This allows the use of the Dynamic Array Visualizer during runs.
2	V2 to V3 converter	Currently, this version works only with the Workshop release version of Version 2 that included a water balance routine.
3	GUI Interface	Install this using the setup.exe file. Also, if there is a newer w2control.exe file in the zip file on the FTP site than installed during setup, use this latest w2control.exe file by overwriting the one installed during setup. The latest file includes the latest bug fixes.

W2 Known Issues

The following list shows known bugs and issues with the current release of the code - these are being addressed in the next release:

#	Item	Description
1	Restart Capability	This has not been tested in Version 3.1 and may not work.
2	Algae mortality by zooplankton grazing	Algae mortality is a constant rate only affected by temperature and is not a function of season (e.g., when zooplankton may be grazing).
3	Water levels in a "bowl"	If water levels decrease in a waterbody shaped like a "bowl", the removal of model layers as the water level decreases will cause the model to bomb if an upstream segment dries up.
4	Pipes under high head	The pipes algorithm does not handle high-head, dynamic flow conditions in a pipe.
5	Time step limitation in a complex system model	The time step for stability in a system model is governed by the lowest time step for numerical stability. If you have a very dynamic river with several reservoirs, the time step for the river will control. This can result in very long run times. One can still break apart the model and run the pieces separately using the WTHOUT files to provide boundary conditions for downstream waterbodies.

#	Item	Description
6	Partitioning	The partitioning coefficient is currently constant for all organic and inorganic compartments
7	O2LIMIT	The concentration at which processes are defined as anaerobic is a step-function ON/OFF switch. A Monod kinetic approach will be used in the next release for smoothing the transition from aerobic to anaerobic conditions
8	Internal weir at a Dam segment	Putting an internal weir at a Dam segment does not affect the outflow from the selective withdrawal structure. One must limit selective withdrawal rather than use an internal weir at the dam segment. Remember the internal weir works for the right-hand-face of a model layer.
9	W2 multiple file error check	If the model user accidentally enters duplicate file names for an input file, the w2 executable will "bomb" because it will try to read the file in more than once. The first use of the file will lock its availability for the second instance. The W2 error message that comes on the screen (traceback error) should mention the file name that has problems. The W2 preprocessor is supposed to now catch this potential error – see bug fix #34.
10	Raising level of spillway/weir above grid	The preprocessor will say there is an error if the user raises the weir, spillway, gate, water level control or any other hydraulic element above the current top-of-the-grid. The w2 code will still run properly though. But more correctly, the model user should increase the DZ of the upper-most layer to a value that would eliminate this problem. But keep in mind that the segment widths from the top layer then extend upward at that same width.
11	Conservation of N, P, and C	Unless the stoichiometry of the organic matter and algae are the same, the code will conserve organic matter but not N, P, or C exactly. This will be fixed in the next release.
12	Internal weirs	The internal weir algorithm does not work when all vertical layers of a segment are blocked by the weir. A check was added to the preprocessor to check for this condition – See Bug Fix #10.
13	Multiple dams into one downstream reach	Currently, the code will allow one dam inflow to a downstream branch by a user-specified outflow file. The code though does allow multiple dams inflowing to a common downstream branch if the outflow is specified as a hydraulic structure.

#	Item	Description
14	Problems reading file in GUI	Sometimes the control file or bathymetry file cannot be read properly by the GUI interface. This can be a result of the text editor used to produce the file. [You will find that the problem file(s) look all messed up in NOTEPAD but look OK in the PFE Editor or in WORD; and W2 usually can read them OK.] Sometimes the following will "fix" the formatting: (1) Copy the file to a UNIX workstation and copy it back. (2) Load the file in WORD as a Text file, add a space somewhere in the file (but don't mess up the file formatting), then save it as a Text file.

W2 V3.1 Bug Fixes, Enhancements, and User Manual Changes

#	Code: W2 or PREW2 or GUI	Fix or Enhance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
1	GUI	Assorted bugs	Problem saving MANN or CHEZY	9-19-02
2	W2	WIND	Changed dimension from IMX to NWB	9-30-02
3	GUI	Problem saving tribs, hydraulic structures, installa-tion	There was a problem with saving updates to pipes, gates, pumps, spillways, internal weirs, and tributaries from the GUI. Also, the installation routine short-cut on the desktop pointed to w2control.exe rather than w2control31.exe. Also a missing installation file that required the user to type 'Ignore' was fixed.	10-7-02
4	W2	TIN	For rare cases when inflows were zero, the code used an incorrect value of TIN that may have affected the computation of temperatures at the boundary segments using a higher-order transport scheme.	10-7-02
5	GUI	EPI and Time Series	Input output errors were fixed when using the time series I/O. Also a bug was corrected when # of EPI=0 (epiphyton groups).	10-08-02

#	Code: W2 or PREW2 or GUI	Fix or Enhance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
6	PRE	Width of structure	If the width of the structure was greater than the segment width, there was a format error in processing the error.	10-11-02
7	W2	Sloping and flat slope within 1 WB	When a waterbody included a branch with zero slope and others with a fixed slope, the grid was incorrectly set up within W2.	10-17-02
8	PRE	Setting up grid	Bug fix #7 was implemented in the Preprocessor so that the 2 codes evaluated the grid similarly	10-17-02
9	PRE	Exit Box & Miscl	The CVF exit box has been removed so that the program finishes without a cryptic message that it finished with error code 0. This caused confusion among users and has been eliminated. Also, some 'false' errors and I/O format errors were corrected.	10-22-02
10	W2	Epiphyton	The calculation of the sources and sinks had a dimensional error. This may affect the magnitude of the kinetic constants used in the computation of Epiphyton growth.	10-22-02
11	W2	Sediment Initial Concentration	Conversion of the sediment initial concentration from g/m^2 to g/m^3. Since the User's Manual has the input dimensions as g/m^2 consistent with the epiphyton input units, we needed to convert to the internal units of g/m^3 for the first order sediment model.	10-22-02
12	PRE	EPI=0	The preprocessor bombed when EPI was set to 0 in the file w2_con.npt.	10-28-02
13	W2	Gregorian Date	The Gregorian date for simulations over multiple years that included a leap year were off by 1 day	10-28-02
14	GUI	Epiphyton Burial rate	The Epiphyton burial rate [EB] did not correctly write out the value into the new control file. Also a header label was mislabeled.	11-6-02

#	Code: W2 or PREW2 or GUI	Fix or Enhance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
15	GUI	Output format and default output variables	The GUI often wrote blanks to the w2_con.npt file when adding new Branches or waterbodies from within the GUI. And often zeroes were written rather than default values. Many of these were corrected and updated. Now if one has an existing w2_con.npt file, when adjusting the # waterbodies or branches, the new w2_con.npt file has many of the 'new' values added automatically. This prevents the time of adding or filling in blanks.	12/27/02
16	W2	TSED	There was a unit error in the code for the sediment temperature heat exchange. The value of CBHE was not divided by RHOWCP. This will mean that much higher default values of CBHE will be necessary. The older default value of 7E-8 $W/m^2/^oC$ is now correctly close to 0.3 $W/m^2/^oC$.	12/27/02
17	W2	MISCL	Miscellaneous minor bug fixes that prevented the model from running unless the # Epiphyton was greater than 1.	12/27/02
18	W2	Reading Solar Radiation	Minor fixes in reading in SRO. Bug Finder: Stewart Rounds, USGS, Portland, OR	1/21/03
19	W2	River modeling	A new feature of the W2 code for a river branch (defined as a branch with Slope not equal to zero) is for it not to subtract layers even when KB becomes less than KT. A fictitious layer of width 0.01 m is added to keep the model running even when KT is more than KB.	1/21/03
20	W2	Ice cover	The solar radiation was accidentally reduced by reflection twice in the older code.	1/21/03
21	GUI	Epiphyton Burial rate	The GUI did not properly read in the value of this variable. It read it in as 0.0.	2/25/03

#	Code: W2 or PREW2 or GUI	Fix or Enhance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
22	W2	River Modeling	A few further updates to bug fix #19 were made that were overlooked earlier (redefined KBMIN, BAREA and reordered computation of segment widths)	2/28/03
23	GUI	Saved File Names	Please read the new GUI document in the full model download file for details. Now the GUI makes backup copies of the control file, bathymetry files and graph file each time the GUI is used to open these files. This allows the user to recover from an error and go back to previous versions of these files.	3/3/2003
24	W2	Derived Variables TP and TN	The derived variables TP and TN did not account for algae and double counted CBODP and CBODN. The derived variables TOP and TON did not account for algae P and N, respectively. Bug Finder: Bob Cusimano, Washington Ecology, Olympia, WA	3/4/2003
25	W2	QIN	QIN displayed on the run time display was shown as '******' if the value was not used in the code. This was fixed by initializing the QIN array to 0.0. This did not affect any model computations.	3/5/03
26	W2	Linkage of model branches	In rare cases for estuaries (either UHS=-1 or DHS=-1), the model did not correctly set up the linkage of the proper head conditions. The model did not run in this situation. Code was reorganized in the section setting up the UP_HEAD and DN_HEAD conditions. Bug Finder: Larry Brower, Honolulu, Hawaii.	3/5/03
27	W2	Derived Variables TP, TN and TKN	This is a follow up on Bug #24. There were several small additional errors that were fixed for TP, TN and TKN.	3/11/03

#	Code: W2 or PREW2 or GUI	Fix or Enhance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
28	W2	River modeling	A further bug fix for KBMIN for Bug fix #22 (kbmin(I-1) recomputed) Bug Finder: Stewart Rounds, USGS, Portland, OR	3/12/03, 3/13/03
29	W2	AKBR – distributed flows	An incorrect computation of the surface area for distributing the DTRs resulted in potentially uneven distribution of the distributed inflows for a river segment.	3/31/03
30	W2	Spreadsheet output	The depths in the spreadsheet output were potentially incorrect for a river system. Bug Finder: Robert Annear, PSU, Portland, OR	3/31/03
31	W2	KT	The model did not constrain KT to always be more than 1. This bug caused the model to crash when water levels were above the grid. This implies that when the water level is above the top of the grid, the width of layer 2 is used.	4/1/03
32	W2	TOC	Derived variable TOC double counted CBODC.	4/1/03
33	W2	Epiphyton	The snapshot output for epiphyton was in units of g/m; this was fixed to the correct output units of g/m^2	4/1/03
34	GUI	ELTRIB and TRIC	The GUI interpreted elevations for TRIB placement as integers rather than real numbers and did not have the TRIC variable in the GUI even though it read and wrote that variable to and from the control file. Bug Finder: Larry Brower	4/15/03
35	GUI	Top View of Grid	The connection of the segments was not correct for cases of branches in series. This error was corrected making the top view of the grid more realistic.	4/15/03

#	Code: W2 or PREW2 or GUI	Fix or Enhance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
36	W2	Surface and sedimentation terms	The surface layer fluxes of gases (DO and CO2) and the surface layer sedimentation rates (for LPOM, RPOM, algae, ISS) were computed incorrectly for the special case where a surface layer extended above layer KT	4/28/03
37	W2	Branch inflows	W2 allows users to change the inputs (water quality) to each branch. This was not implemented properly, so if a user had different water quality variables in different inflows the code did not handle it properly.	4/28/03
38	W2	Flux Output	The flux output variables in the User Manual states they are in kg/day, but they were accidentally output in units of g/day. This has been fixed so that all flux variables are in kg/d.	5/20/03
39	GUI	Merging/ Splitting segments	(1) In the GUI bathymetry editor, when the number of segments was changed by merging or splitting segments, the segment #'s in the I/O statements: SNP, PRF, SPR, TSR and WDO were not updated. (2) In some cases, the output format for new segment widths defaulted to .XXEXX after a merge/split. This has been fixed to allow proper # of digits in the F8 field for layer widths. (3) When merging segments, water levels, friction, and orientation angles were only averaged globally for the new segments. Now there is interpolation of these onto the new segments.	5/28/03
40	W2	Side branch momentum	Fixes were made in computing UXBR at branch intersections	6/12/03
41	W2	Flux output	Further minor fixes for I/O for flux output	6/12/03

#	Code: W2 or PREW2 or GUI	Fix or Enhance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
42	W2	Flow transfer between waterbodies	A minor fix in QSS(K,DHST), prior to this DHS was used instead of DHST. This would cause a problem in waterbody-to-waterbody connections where the downstream waterbody started to loose segments	6/12/03
43	GUI	I/O format and variable naming	The I/O format and the variable naming was altered for the GRAPH.NPT file	6/12/03
44	W2	TDG at spillways	An internal variable [CDSUM] referring to the order of the derived variable TDG (total dissolved gas) was incorrect.	7/8/03
45	W2	Code	Some internal code was re-written since some variables did not need to have the code allocate memory. Hence memory allocation was reduced.	7/8/03
46	W2	Shading	For full topographic shading, the maximum shading was set to 0.9 from 1.0 allowing for diffuse radiation even in a shadow.	7/16/03
47	W2	Hydraulic elements	If a downstream branch received 2 or more hydraulic element inflows and these were specified as ‘DOWN’ in the upstream branch, the flow accounting was not done correctly.	7/16/03
48	GUI Installa-tion	GUI	An installation error on the GUI was fixed using a work-around from MS Visual Basic. The installation error stated: 'An Error Occurred While Registering the file: C:\WINDOWS\SYSTEM32\msado25.tbl'. If the user chose ‘Ignore’ the installation was fine. This error message has been corrected so that the user no longer needs to choose ‘ignore’.	7/21/03
49	W2	Floating Algae	Model Enhancement: The model correctly handles algae with negative settling velocities, i.e., floating algae. This enhancement marks Version 3.12	7/24/03

#	Code: W2 or PREW2 or GUI	Fix or Enhance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
50	W2	Derived variable output	In the derived variable output for the WDOUT file, the derived variable computation for TDG was incorrectly summed.	7/24/03
51	W2	Restart	The Restart option now works.	8/1/03
52	W2	TSR output	New output variables have been added to the TSR file. These include: SRON, ET, SHADE, DEPTH, SURFACE WIDTH	8/1/03
53	W2	Auto-stepping algorithm	The way the time step increases after a time step violation has been revised slightly.	8/1/03
54	GUI	Interpol-ation	The interpolation variables QINIC, HDIC, DTRIC, and WDIC were not editable from the GUI. These variables were added (finally) to the GUI.	8/12/03
55	GUI	Calendar	The calendar function under the Time Control returned a Julian date that was 1 day off. The older Version 2 convention was used where January 1 at 12 noon was 0.5. This was fixed to the Version 3 convention which sets Jan 1 at 12 noon to Julian day 1.5.	8/12/03

56	W2	pH	Ionic strength equation was
			IF (SALT_WATER(JW)) S2 = 1.47E-3+1.9885E-2*TDS(K,I)+3.8E-4*TDS(K,I)*TDS(K,I)
			But was changed to
			IF (SALT_WATER(JW)) S2 = 1.47E-3+1.9885E-2*TDS(K,I)+3.8E-5*TDS(K,I)*TDS(K,I)
			Because of an earlier typo. Stewart Rounds.
				11/25/03

#	Code: W2 or PREW2 or GUI	Fix or Enhance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
57	W2	pH	Equilibrium constant for KW as a function of Temperature was not in exact agreement with tabulated values. The old equation was KW = 10.0**(-5242.39/T1K+35.3944-8.350E-3*T1K-11.8261*LOG10(T1K))/OH The replacement from Stumm and Morgan (3rd edition): kw=10.0**(-283.9710-0.05069842*t1k+13323.00/t1k+102.24447*log10(t1k)-1119669./(t1k*t1k))/OH ! Stumm and Morgan 3rd edition SR 11/25/03 This only affected results in a series of tests to at most 3rd decimal point accuracy. Stewart Rounds.	11/25/03
58	W2	GRAV	Initialized the array GRAV	11/25/03
59	W2	Sun rise-sun set	Changed to the earlier version of the variable HH. This may affect sunrise and sunset hour depending on your longitude. Old: HH(JW) = 0.261799*(HOUR+(LOCAL-STANDARD)*0.0666667+EQTNEW-12.0) New: HH(JW) = 0.261799*(HOUR-(LOCAL-STANDARD)*0.0666667+EQTNEW-12.0) Occurs in 2 places in the code	11/25/03, 1/1/04
60	W2	TSEDF	Short wave solar radiation penetration to the bed was not computed correctly if there were multiple vertical layers. The one-layer system results were still valid. This error did not allow the short wave solar that was computed at the bottom of the vertical layer to be available to the water in the bottom layer – it had the impact of a TSEDF=0 only for the bottom layer in a multiple layer system.	11/25/03

#	Code: W2 or PREW2 or GUI	Fix or Enhance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
61	W2	FLUX output	Flux output formats were corrected and updated	11/25/03
62	W2	Epiphyton	Added a line of code to prevent negative concentrations of epiphyton in the case of no epihpyton but continued mortality: New line: EPI(K,I,J) = MAX(EPI(K,I,J),0.0)	12/3/03
63	W2	DZ in KT	The value of DZ was overcorrected for stratification effects (if they were evident between the 1st and 2nd layers only) Old code: DZ(KT,I) = MAX(DZMIN,FRAZDZ*(AZ(KT,I)*EXPAZ+ DZMIN*(1.0-EXPAZ))) Fixed code: DZ(KT,I) = MAX(DZMIN,FRAZDZ*(AZ0*EXPAZ+DZ MIN*(1.0-EXPAZ)))	1/1/04
64	W2	Reading in EXT	A problem was fixed reading in dynamic extinction coefficients for the first time interval	1/5/04
65	W2	Output format for TSR file	Fixed output headers for TSR file when Epiphyton were being modeled	1/12/04
66	Examples and Manual	DTRIC variable	In the control files in the example problems and in the manual, the variable DTRIC header in w2_con.npt was used twice. This was corrected in the headers and in the User Manual. The GUI, W2 and the preprocessor read these files correctly.	1/28/04
67	W2 Manual	Revisions	Minor revisions, corrections of typos, and additional explanatory figures were added to the User Manual	1/28/04
68	W2	Suspended sediment	Earlier revisions introduced a bug in the suspended solids routine only allowing settling from the bottom layer.	2/5/04
69	W2	Revised IMP code	A code revision in the Thomas algorithm for the implicit vertical shear stress computation. No effect on model results.	2/14/04

#	Code: W2 or PREW2 or GUI	Fix or Enhance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
70	W2	DLT	Minor adjustment of DLT computation to allow smoother transitions of time steps when a violation occurs.	2/14/04
71	W2	RESTART option	Improved Restart option capability, added more variables to the restart output	2/14/04
72	W2	Evaporation	The surface width to compute water loss during evaporation was based on the width of the surface layer KT. It is possible under some conditions for the correct width to be B at KTI, which is the width of the water surface. Old code was EV(I) = VPTG*(T2(KT,I)-TDEW(JW))*FW*B(KT,I)*DLX(I)/2.45E9 Fix is EV(I) = VPTG*(T2(KT,I)-TDEW(JW))*FW*B(KTI(I),I)*DLX(I)/2.45E9 ! SW 1/23/04	2/23/04
73	W2	Waterbody-waterbody linkage	For some cases of waterbody-waterbody linkages (based on grid meshing), there was a “leak” of flow unaccounted for.	6/25/04
74	W2	Short-wave solar radiation	Computation of theoretical clear-sky radiation in the W2 code when using term-by-term approach resulted in reflection (6%) being subtracted. A search of the actual reference showed that this theoretical term already included reflection and was the net at the water surface. Hence, only for theoretical computations of SRO the REFL variable was removed. For SRO read in from the met file, reflection is still accounted for in the code since this is expected only to be net incident short wave solar.	6/25/04
75	W2	Waterbody-waterbody linkage	A continuation of bug fix #73 – problem fixed.	7/21/04

#	Code: W2 or PREW2 or GUI	Fix or Enhance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
76	W2	DO sat for salt water	DO saturation correction for salt water had an incorrect term in its regression equation	7/23/04
77	W2	Waterbody-waterbody connection	In cases where there is a waterbody-waterbody connection and there is reverse flow from downstream to upstream, there was the possibility of temperature and concentration anomalies if the grid was aligned in a specific fashion.	8/31/04

78	W2	GRAV	The magnitude of the gravity term for the surface layer was examined in the light of the HPG term. The old code was
			`! GRAV(KT,I) = BHRKT2(I)*G*SINA(JB)`
			The new code is
			`GRAV(KT,I) = avrhkt(i)*(bkt(i)+bkt(i+1))*0.5*G*SINA(JB)`
			This new code would affect circulation when the grid is sloped but the water surface is flat and the system is stratified.
				9/9/04

79	W2	Lateral withdrawal	Fixed potential bug in case KB(ID) is less than KB(I). Old code:
			If(kbot>kb(id))kbot=kb(id)
			Fix:
			If(kbot>kb(i))kbot=kb(i)
			Stewart Rounds, USGS
				10/1/04

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W2 Planned Enhancements for 2003

The following list shows planned enhancements for the year 2003:

#	Item	Description
1	Sediment Diagenesis	Complex sediment diagenesis model
2	Simultaneous water level solution	Currently, water surface is solved branch-by-branch. The new technique will involve solving all water surfaces for the system or waterbody simultaneously.
3	Macrophytes and periphyton	Water quality and hydrodynamic effect of macrophytes and periphyton.
4	k-ε turbulence model	k-ε turbulence model that will collapse all turbulent eddy viscosity formulations into one